Agriculture and Solar Energy Development in Massachusetts:

Potential Conflicts and Synergies

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Abstract

This research explores conflicts and synergies between preserving farmland and scaling up solar development in Massachusetts. As solar technology and farming require similar inputs, it is prudent to consider ways that solar can aid farms' success. This work strives to understand whether agriculture and solar are compatible; to identify potential conflicts; and to develop a model for quantifying land available for solar development. Using snowball sampling to select sixteen experts—farmers, solar developers, and other stakeholders—I conducted semi-structured interviews from which several themes emerged: solar is a means of farm diversification; many farmers feel favorably about solar on farmland; the lack of rural electrical infrastructure and the seasonal constraints unique to farming are primary obstacles to expanding solar to farms; and solar companies exhibit varying capacities to work with farms. This study begins to fill the gaps in knowledge surrounding the intersection of Massachusetts' agricultural and solar energy sectors.

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Chapter 1: Introduction

A growing global population means increasing human requirements for food and energy worldwide. Both of these essential sectors will escalate demands for land and put greater strain on the Earth's already-stressed climate. According to the Energy Information Administration (EIA), energy production in the United States is expected to rise by 27 percent in order to meet energy demands both domestically and abroad by the year 2040 (EIA, 2013). Meanwhile, scientists in a variety of fields have concerned themselves with how humanity will feed an estimated 9 billion by the year 2050.

Researchers and policy makers have anticipated these problems for decades. The energy and agricultural industries are independently making strides toward efficiency and land use maximization: the energy sector is rapidly looking toward renewable sources like solar, that rely less on "dirty" and depletable fossil fuels, while farm operations around the globe are taking steps toward both sustainability and intensification.

When both industries compete simultaneously for land inputs, however, efficiency gains that are siloed to each respective industry are insufficient. Despite noble intentions for efficiency and sustainability, the unintended consequence of separately scaling up renewable energy and prioritizing the preservation of land in agriculture is that these objectives compete for relatively flat land, cleared of trees and brush, with ample access to sunlight. This competition between land uses seems ripe for forcing tradeoffs between environmental policies—equally progressive and

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important, but driving land values higher, a significant factor in making land unaffordable for most farmers.

As a state, Massachusetts is fairly forward-thinking when it comes to environmental policy, and indeed it has prioritized both a strong regional food economy as well as a commitment to decreasing reliance on fossil fuels in the state. However, the ability to meet multiple targets requires not only a multidisciplinary approach, wherein different sectors work on the same problem separately, but a transdisciplinary one, wherein different sectors work together in a focused manner toward a common goal.

This research explores the potential conflicts and synergies at work between preserving land for agriculture while simultaneously making room for new solar energy development in Massachusetts. The Massachusetts Food Policy Council has developed a statewide Food Plan to support and expand local agriculture in the state. Additionally, through its Solar Massachusetts Renewable Targets (SMART) program, the Commonwealth aims to scale up its production and use of solar renewable energy to reduce reliance on fossil fuels and meet reduction targets for carbon emissions. However, some within the Commonwealth anticipate solar development as a threat to farmland, despite the state's dual goals of increasing solar development and farmland protection. As such, there are policy tensions brewing and with that, a need to critically assess the extent and impact of those conflicts, and if they exist, how best to resolve them. As such, this research aims to answer the following questions:

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Question 1: Are Massachusetts agriculture and solar energy development compatible? (Is there any coordination between the two, or are they developing separately?)

Question 2: Are there potentials for conflict between the two goals?

Question 3: If currently protected agricultural land (through APR program) and prime agricultural soils are protected, approximately how much area is available for solar energy development in Massachusetts?

Significance to the field

While dialogue at the federal level seems to threaten U.S. progress on energy issues (Groom, 2018), Massachusetts holds steady as a national leader on solar (SEIA, 2018b). Massachusetts policymakers currently face a critical moment, positioned as they are to shape the state's solar policy for the foreseeable future, with an eye to guiding solar policy in the rest of the country. The solar industry is on the cusp of taking off nationally, while simultaneously the number of farms, farmers, and acres in agriculture continues to trend downward across the country, with midsized farms being the most vulnerable to conversion out of agriculture (USDA, 2014). There are several reasons for the decline of farm economies, including depressed crop prices; declining net farm income; inadequate access to capital, tools and training; an aging farm population; and perhaps most critically, limited access to land (Ackoff, Bahrenburg, and Shute, 2017).

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Food production and solar energy production require many of the same inputs: cleared, open land area and ample access to sunlight. On the surface this seems ripe for conflict. Proponents of each respective sector, however, also share many of the same values—sustainability, innovation, resilience, and environmental stewardship—revealing surprising opportunities for alliance. As the solar industry is poised for growth, it is prudent to consider ways that the energy sector can aid in the success of farms, something that Massachusetts is attempting to pioneer through the agricultural incentives introduced in the state's new SMART program.

Although Gerry Palano, Renewable Energy Coordinator for the Massachusetts Department of Agricultural Resources (MDAR), champions solar and agriculture as dual land uses, he also acknowledges the need for more data and deeper understanding of the conflicts and synergies in this space, cautioning that "we're in the learning, beginning stages of trying to now make [solar and agriculture dual use] a national effort," (G. Palano, personal communication, April 10, 2018). This research uses qualitative interviews with farmers, solar developers, and other stakeholders as a starting point for delving into those potential conflicts and synergies at play in Massachusetts.

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Chapter 2: Literature review

This literature review addresses four areas related to the extent to which agriculture and solar energy development are competitive land uses. While the scope of this research paper focuses narrowly on agriculture and solar development in the state of Massachusetts, the academic literature and this literature review speak more broadly to agriculture and renewable energy as discrete or compatible land uses in North America as a whole. The first section will describe the methods undertaken to conduct this literature review. The next section will be comprised of four parts: (1) it will address long-held legal processes for designating and preserving land for particular uses; (2) it will focus on land impacts and use efficiencies of various types of energy production; (3) it will look at localized public reactions to renewable energy development and how planners and decision makers might respond; and finally, (4) it will discuss research related to agrivoltaic systems, or the co-location of agriculture and photovoltaic energy production on the same parcels of land.

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Review methodology

This literature review was initiated by selecting online databases through which to conduct the search. As this research is interested in land use planning as it pertains to agriculture, I chose to conduct my search through two agricultural databases and one more general science database: PubAg National Agricultural Library, ProQuest Agricultural & Environmental Science Database, and Web of Science. TABLE 1 shows the Boolean phrases used to search each database, the number of results yielded and of those, the number of abstracts that at first glance appeared to be useful for this literature review.

TABLE 1. BOOLEAN PHRASES USED TO SEARCH THE LITERATURE.

Database	Boolean search term(s)	Yield	Useful
PubAg	"land use" AND "solar energy"	32	5
	preservation restriction	80	3
ProQuest	"land use" AND "agrivoltaic"	2	1
	"easement" AND "solar energy"	27	2
Web of Science	"land use" AND "solar energy" AND "agriculture"	9	2
	"solar" AND "easement"	9	2
	"land use" AND "photovoltaic"	114	11

Some articles appeared in multiple searches. In TABLE 1, duplicate yields were counted only in the first search in which they appeared. Articles deemed useful were downloaded and read more thoroughly to determine viability for this literature review; some of these were culled further.

Several of the yielded, useful results were abstracts on case studies performed outside of North America. While many of these cases might certainly be informative on the topic of land use and agrivoltaics more broadly, American land use planning is rooted in English common law. As such, I also chose to exclude articles discussing land use planning in countries outside of North America, further narrowing the search to those most applicable under American common law. With the exception of early

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landmark research on agrivoltaics in Germany and France, most international articles were considered irrelevant for this research synthesis.

Notably, I did include two relevant planning articles published in the 1980s. While convention is to include only those articles from within the last five to ten years (more recent literature being the most preferable), common law regarding property ownership does not tend to change frequently or drastically over time. As such, older articles continue to inform our understanding of current land uses, property rights, and the legal mechanisms that enforce them.

The resulting literature chosen for this review includes 14 sources referenced. Eight of these were derived from the searches described in TABLE 1, above, as well as six articles from earlier preliminary searches through Web of Science and from perusing relevant papers' references sections.

Legal frameworks for land use and solar access planning

We cannot understand the inherent tensions in land use planning without a firm understanding of the legal framework that governs decision making over land parcels and their uses. As the focus of this paper is to analyze agriculture and solar energy development as competing land uses, I wanted to first understand the legal mechanisms that protect land for these specific uses.

While photovoltaic (PV) technology is relatively new, only becoming economically feasible and widespread within the last 20 years, the question

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of access to sunlight dates back centuries, documented as long ago as ancient Greek and Roman times. More recently, according to Pedowitz (1980) and Eisenstadt (1982), English common law took an interest in protecting landowners' access to sunlight, holding to the "doctrine of ancient lights," wherein if a person had uninterrupted use of light and air for at least 20 years, an adjoining landowner was not permitted to build any structure which might block the light on their neighbor's property. This doctrine was upheld in early America as part of English common law until it was rejected by a New York court in 1838[1] on grounds of public policy, for the reason that it could not be applied to growing cities "without working the most mischievous consequences," (Eisenstadt, 1982, quoting *Parker v. Foote*, p. 21). Since then, American courts have favored enforcement of access to light and air instead through contract, statute, and zoning (Pedowitz, 1980; Eisenstadt, 1982). The remainder of this section will discuss the literature advising on methods for providing and protecting solar access in land use planning.

Eisenstadt (1982) describes several contractual methods of providing and preserving solar access:

a. SOLAR ENERGY EASEMENTS AND RESTRICTIVE COVENANTS. Solar easements, written into a property's deed, allow passage of solar radiation, light, air, or heat across an abutter's property by placing negative burden(s) on neighbors' development rights. Valid without statutory support,

[1] *Parker v. Foote*, 19 Wendell 309 (NY 1838).

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easements rely on private transactions, and usually run with the land. Restrictive covenants work in much the same way, but are private agreements between buyers and sellers of real estate, often designed to preserve neighborhood aesthetic. On easements, Pedowitz (1980) stresses the need to take special care in recording conveyances, noting that failure to comply with any local statutes pertaining to solar access or existing zoning requirements could invalidate the terms of a private easement (p. 799-800). Similarly, a more recent policy comment on proposals for solar in Ontario cautions that any easement or restrictive covenant must be detailed and precisely worded; easements that are not explicit about the dominant and servient parcels or the nature of the burden are unenforceable (Alizadeh, 2017) and potentially subject to the interpretation of the court.[2]

b. NUISANCE LAW. Private nuisance involves activity on one party's property that inhibits the ability of a neighboring party to fully use or enjoy their own land (typically a conflict over land uses in a single neighborhood). Although nuisance law may be employed to prohibit shade over a party's property, it is an unpredictable means of enforcing solar access, requires litigation for each instance, only

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[2] The doctrine of *cy pres* is roughly translated from French to mean "as near as possible." When the original objective of a legal document is uncertain due to vaguely worded language, *cy pres* may be invoked to allow amendment of the terms as closely as possible to the original intentions of the grantor, per the court's interpretation and legal ability. *Black's Law Dictionary Free Online Legal Dictionary, 2nd Ed.*

protects existing solar collectors (not potential future sites), and may work against state or municipal legislation concerning solar development. In the absence of an ordinance or statute declaring the shading of solar collectors to be a nuisance, this is not a reliable means of securing continuous access to sunlight.

c. PERMITS AND LICENSING. A permit system would receive applications and then notify all potentially affected neighbors about intent to conduct a hearing. Concerned parties would have opportunity to voice objections before the governing body prior to their decision. If granted, the permit would take the form of an easement and be recorded in local property records. Neighbors who later wish to develop their property in a way that would affect the permit holder's solar access would need to purchase their neighbor's certificate granting access.

Eisenstadt next turns attention to state statutes on solar access. At the time of Pedowitz' and Eisenstadt's writings (1980 and 1982, respectively), only California and New Mexico had enacted laws to directly create solar access. The California *State Solar Shade Control Act* of 1979 protects solar access by prohibiting shade from a neighbor's vegetation over greater than 10 percent of the solar collector's surface area between the hours of 10 a.m. and 2 p.m. (Eisenstadt, 1982, summarizing California's *State Shade Solar Act*, p. 34). It also mandates that solar collectors comply with all local building, setback, and height regulations. Violations of the statute are considered

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public nuisances, alleviating some of the uncertainty of relying on private nuisance laws by eliminating the need for litigating each case (p. 34).

New Mexico's *Solar Rights Act* of 1978 is broader and more radical, having been modeled after the law of prior appropriation used for water in the west (Pedowitz, 1980). As with water, prior appropriation of sunlight favors landowners who first appropriate a resource for beneficial use, a common law principle of allocation known as "first in time, first in right." Prior appropriation in this case requires solar energy to be used continuously and beneficially in order for the right holder to retain the right. Failure to establish continuous beneficial use constitutes an abandonment of the resource and termination of the right (Eisenstadt, 1982, p. 36). However, the New Mexico law (like prior appropriation doctrine) provides for transferability. This gives rights holders the flexibility to sell solar access rights, in part or in full, to another party who may either put the right to greater beneficial use or choose to legally erect a shade-casting structure despite the otherwise restrictive burdens on their property (Eisenstadt, 1982, p. 38).

The work of Klass (2011) takes an updated look at property rights as they pertain to natural resources and burgeoning renewable energy, in what she terms "the new frontier" of natural resources law (p. 66). It is useful to compare her table showing state statutes on solar rights and permits systems (reproduced below, TABLE 2) to gain an understanding of how states' statutory frameworks have progressed in since the late 1970s.

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TABLE 2. STATE STATUTES ON SOLAR RIGHTS AND PERMITS SYSTEMS. *

Type of Statute	States
Allows for solar easements	Alaska, California, Georgia, Kansas, Kentucky, Missouri, Montana, New Hampshire, North Dakota, Ohio, and Tennessee have enacted such legislation. Colorado, Florida, Indiana, Iowa, Maine, Maryland, Massachusetts, Minnesota, Nebraska, Nevada, New Jersey, New Mexico, New York, Oregon, Rhode Island, Utah, Virginia, Washington, and Wisconsin include solar easements in a broader statutory scheme. Idaho's legislation allows local governments to recognize such easements.
Invalidates property conveyance limitations on solar energy systems	Arizona, California, Colorado, Delaware, Florida, Hawaii, Illinois, Massachusetts, Nevada, North Carolina, Vermont, and Wisconsin have statutes rendering void property conveyances entered into after the effective date of the statute that prohibit use of solar collection systems. Maryland's statute applies retroactively.
Invalidates common interest community (homeowner association) restrictions on solar energy systems	Arizona, California, Hawaii, Illinois, Maryland, New Jersey, North Carolina, Virgina, and Washington limit common interest community regulation of solar collectors.
Prohibits local restrictions on solar energy systems or encourages local solar ordinance enactment	California, Indiana, Maine, Nevada, New Mexico, and North Carolina prohibit the local ordinances that ban the installation of solar systems. California, Massachusetts, Minnesota, Nebraska, New York, Oregon, and Utah have statues specifically allowing or encouraging the enactment of local ordinances and/or zoning policies supporting solar energy. Rhode Island requires local governments to enact zoning ordinances that consider solar power.
Solar permitting statutes	California, Iowa, New Mexico, Wisconsin, and Wyoming have statutes that allow various forms of solar access permits by state or local governments.

* SOURCE: Klass, AB. (2011). P. 101-102.

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Taking a slightly different tack than either Pedowitz (1980) or Eisenstadt (1982), Klass (2011) considers renewable energy (both solar and wind) in the context of historical approaches to natural resources law and pollution control law. From these, she gleans insights into how states might use easements and property rights to achieve energy independence and climate change goals. Klass proposes that policymakers avoid relying too heavily on traditional natural resource frameworks, and instead favor approaches that lean on state and local permitting systems for land use.

Klass first compares the purposes of natural resources law—"to convey property rights in natural resources to private parties and encourage westward expansion and economic development,"—to pollution control law, which places limits on property and resource development rights that would harm the environment if left unchecked (Klass, 2011, p. 65-66). As Pedowitz and Eisenstadt do, she draws parallels between permitting and property conveyance frameworks for solar development and the prior appropriation doctrine used in the west to allocate water rights (Klass, 2011). She also notes that some states base wind rights on the historical framework for mineral development, which would sever wind rights from surface rights (Klass, 2011). She cautions policymakers against the use of natural resource development as the framework for developing wind and solar, advising that instead of thinking of pollution control as a later overlay to destructive natural resources laws, thoughtful consideration of pollution mitigation and

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environmental protection should be fully integrated from the outset of renewable energy development (Klass, 2011).

We turn attention now to the land itself, and mechanisms available to property owners for protecting land for agriculture. Agricultural Preservation Restrictions (APRs) are a particular kind of conservation easement. APRs have a twofold purpose: they not only strive to protect land from non-agricultural development, but they also are one strategy for helping agricultural businesses remain economically viable. In *The Conservation Easement Handbook*, Byers and Ponte quote Jerry Cosgrove of American Farmland Trust, emphasizing that "conserving farms and ranches involves more than protecting land—it entails finding ways for farming and ranching operations to survive," (Jerry Cosgrove, as quoted by Byers & Ponte, 2005, p. 199). This very objective is reflected in the Massachusetts Local Food Action Plan's Land Goal 2, envisioning that "more farmland and prime farmland soils will be permanently protected" by utilizing strategies like expanding the APR program and zoning for transfers of development rights (TDR) as tools for farmland protection.

Putting land into APR or selling rights through TDR programs can be appealing to farmers. Conserving the land, keeping it in agricultural use, helping to transfer ownership to heirs, and helping farmers stay in business are all cited as reasons that farmers voluntarily sell the development rights to their land (Byers & Ponte, 2005, p. 200). As a result, these are not only

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useful tools for established farmers. Because farmland is already scarce, it is especially difficult for beginning farmers and ranchers with little capital to obtain and afford. Preventing the loss of farmland to development and assessing its value at current use rather than potential use therefore ensures an affordable land base and encourages retiring farmers to find heirs to take over and farm their land, rather than selling it to the highest bidder.

An advantage of APRs is their flexibility. Using APRs, easement holders and landowners work together to balance the land's conservation value with the farmer's need to adapt to market conditions by expanding farm operations or changing farming or ranching practices. This is very important for ensuring a farm's economic viability, and easement holders are careful to prescribe flexible management plans (Byers & Ponte, 2005, p. 202-204). For landowners receiving federal dollars for their easement, conservation plans designed to minimize erosion, preserve wetlands, riparian areas and water quality, or encourage plant diversity are often developed based on standards set by the Natural Resources Conservation Service (Byers & Ponte, 2005, p. 204); however, taking a flexible approach allows landowners to fine-tune their management practices over time while adapting to the needs of their farm operation.

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Land use impacts of energy production

Like agriculture, all energy development projects, whether fossil fuels, biofuels, or renewable energy projects, require land area. According to the

Energy Information Administration (EIA) energy production in the United States is expected to rise by 27 percent in order to meet energy demands both domestically and abroad by the year 2040 (EIA, 2013). The question for planners then, is how to meet those demands while promoting environmental conservation and balancing competing land uses.

We know that not all methods of energy production are created equal. In their study on energy sprawl as the largest driver of land use change in the United States, Trainor, McDonald and Fargione (2016) quantified land area estimates required to meet energy demands through 2040 using a hypothetical comparison of different production methods, including renewables (wind, solar, hydroelectric, geothermal, and bioelectricity); biofuels (ethanol, biodiesel, and other fuels from biomass); mined energy sources (coal, nuclear); and drilled energy sources (oil, natural gas, shale gas, tight gas, and coalbed methane). They looked at land use efficiency, or the amount of land required to produce a given amount of energy per year, for each energy sector. Although renewables often require a large surface footprint, they are not extractive the way fossil fuels are. The ability for renewables to increase cumulative energy production on the same land base year after year requires an additional consideration: "time to land use equivalency," or the number of years it would take extractive energy sources to achieve the same land footprint as renewable energy for an equivalent accumulation of useable energy (Trainor, McDonald & Fargione, 2016).

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